# THE GEORGIA SEEDLING HARVESTER

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Forest tree seedlings are normally harvested manually. The need for accomplishing this work mechanically has long been recognized; however, no suitable machine has been available. Realizing that mechanization of the lifting operation is essential if maximum efficiency in nursery operation is to be obtained, the Commission initiated a study in 1956 to develop a mechanical seedling harvester. A cooperative agreement was entered into with the Agricultural Engineering Department of the University of Georgia, to jointly develop a machine that would harvest tree seedlings. The Commission agreed to finance the project, make its personnel and nursery facilities available for testing, and modify experimental machines if required. The Agricultural Engineering Department of the University of Georgia agreed to furnish technical guidance, skilled labor, and shop facilities for constructing a harvester. Personnel of both agencies were to be available during testing. The developed machine would be the property of the Georgia Forestry Commission.

The Commission, acting through the writer, had certain ideas as to how the desired machine could be made. These were conveyed to Dr. C. E. Rice of the University. As a result of preliminary discussions, basic requirements for the harvester were determined and used as guides. It was determined that the machine should:

1. Lift seedlings that had been undercut at 10 inches below the soil surface.
2. Lift a full 4-foot bed of seedlings.
3. Remove soil from the roots.
4. Lift plants having fibrous root systems that were equal or superior to hand-lifted seedlings.
5. Keep the seedlings in order with tops together.
6. Place the plants into containers.

A review of the literature on harvesting machines furnished little information that was of assistance in constructing a machine suitable for harvesting pine seedlings. Tree seedlings of various species had been harvested with a mechanical potato digger. This machine has worked satisfactorily on some northern species, especially 2- or 3-year-old stock. When the potato digger was tried on 1-0 trees, it had the undesirable characteristic of mixing them to the extent that extra time was required in packaging them for shipment. Data on an onion harvester which used belts for lifting was obtained from the literature. It was also noted that a mechanical radish harvester employed lifting belts to accomplish its harvesting.

Several theories were mutually developed for a number of methods of harvesting seedlings. It was proposed that the following three methods be considered.

1. Use of lifting belts and potato digger chains for elevating trees and soil.
2. Use of belts for lifting and mechanical agitators for removal of soil from the roots.
3. Use of a potato digger with conveying guides for keeping the tops together.

The primary purpose in the initial experimental machine was to test the theory of using lifting belts and potato digger chains for harvesting (fig. 1). This proved unsatisfactory during testing, however, as the soil removal unit did not adequately clean the roots. In addition, excessive loss was caused by roots becoming entangled in the chains. The lifting belts removed trees from seedbeds but many plants were pulled from the belts by soil adhering to the roots.

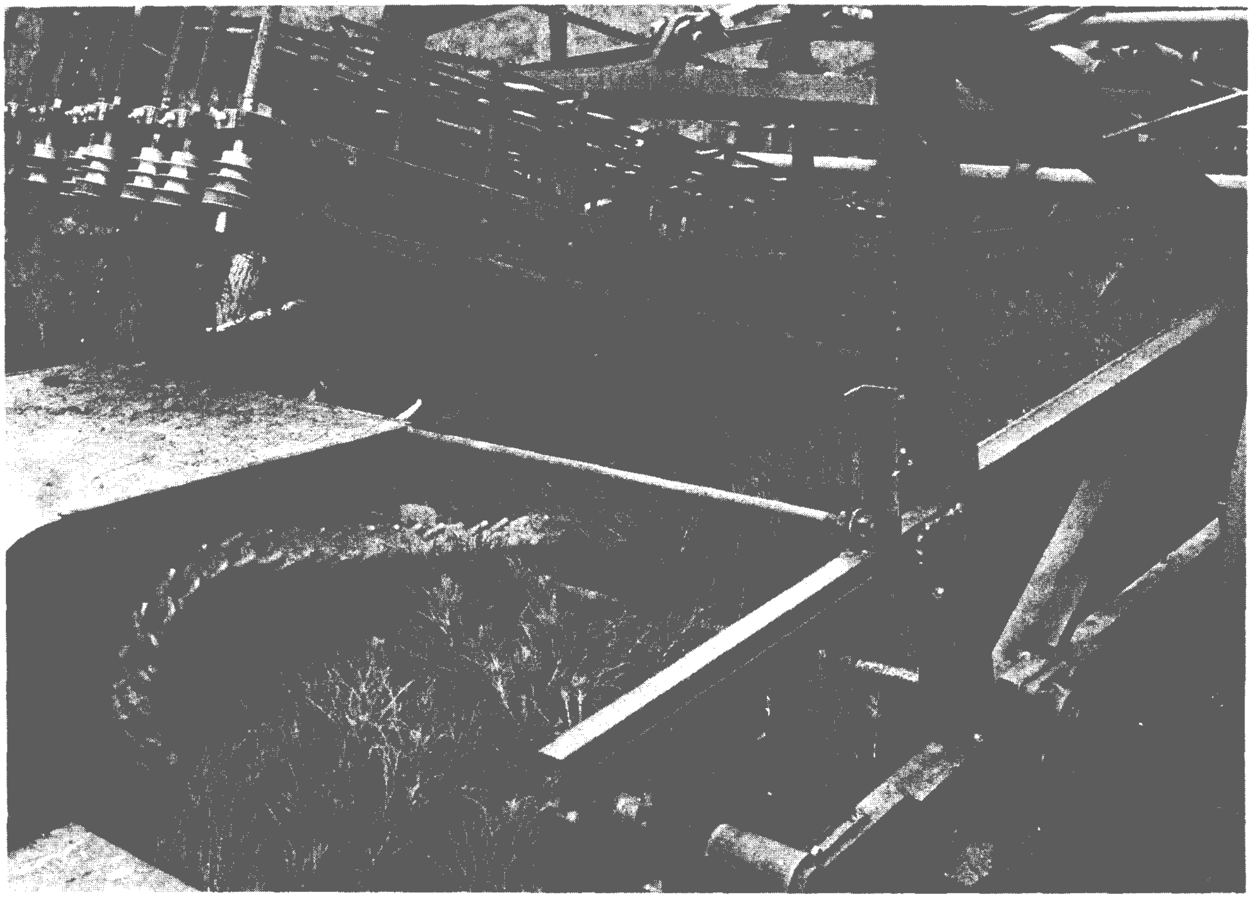

Figure 1.--Experimental harvester showing lifting belts and potato digger chain for removing soil.

The experimental machine was equipped with various sets of lifting belts. The following combinations were tested: single v-belts, double v-belts, sponge-covered v-belts, special double notched flat rubber belts; Field trials proved that the special double notched flat rubber belts were the most suitable for use in removing trees from seedbeds. Data obtained from field tests indicated that lifting belts and mechanical agitators provided the desired combination. Method three above was not pursued as it appeared the least likely to succeed.

Extensive alterations were made to the experimental lifter in 1958. In December of that year the machine successfully harvested seedlings at the Commission's Hightower Nursery, Gainesville, Ga. Plants were removed from the soil, deposited onto a conveyor, and placed in a container. Plans were prepared, as a result of the 1958 test, for construction of a modified harvester utilizing the principle proved with the experimental machine.

Early in the construction of the modified harvester it was realized that serious space problems existed. Slash and loblolly seedlings are normally planted in 6-inch drills, thus each 4-foot seedbed contains eight rows of trees. The complete lifting unit for each drill could be only 6 inches wide, so very small pulleys would have to be used. Belt slippage, due to the use of small pulleys, was a major obstacle in the construction of the new harvester.

A lifting blade for undercutting seedlings had been attached to the experimental machine. The undercutting blade was not added to the modified harvester, as past tests had revealed it was more desirable to undercut seedlings in a separate operation. When the undercutting blade was attached immediately before the lifting belts, the action of the rising soil had a tendency to jam the belts, thereby making it necessary to stop harvesting until adjustments could be made.

The lifting belts are arranged insets and travel to the rear of the harvester as plants enter. Since the belts are inclined, as the plants proceed to the rear of the machine they are automatically removed from the soil (fig. 2). The speed of the lifting belts slightly exceeds the forward speed of the machine; this results in the plants being lifted upward. In the harvesting operation the entire surface of the 4-foot seedbed is lifted by the action of the belts and the fibrous root systems of the seedlings. Mechanical agitators act as soil beaters for use in removing dirt from the seedling roots. The mechanical agitators are constructed from rubber fingers which are used for cleaning chickens commercially. These chicken picker fingers do an outstanding job of removing soil from seedling roots without damaging the plants.

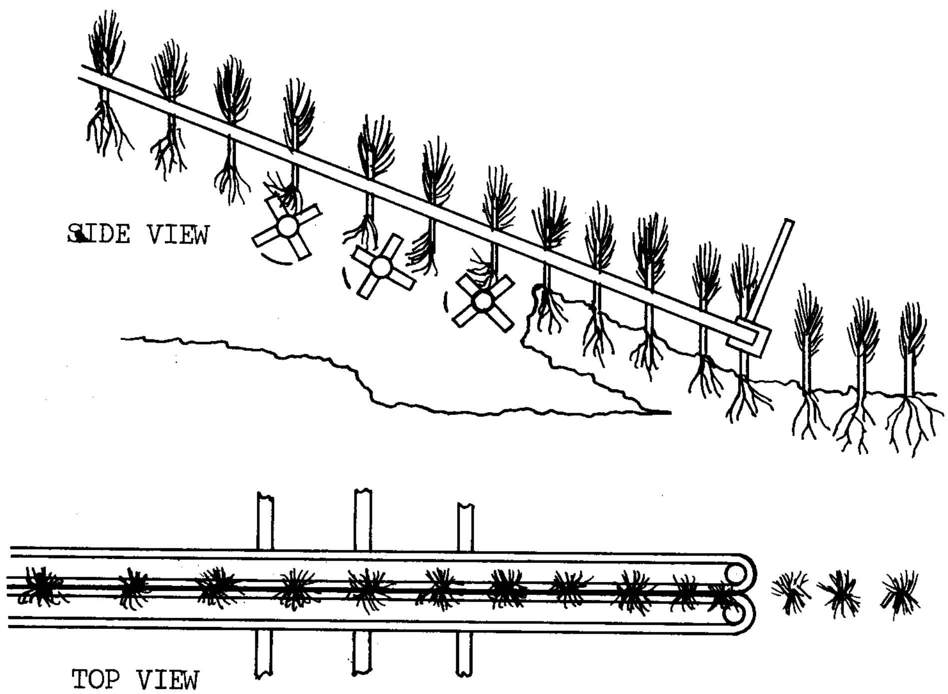


Figure 2.--Schematic drawing of lifting belts and soil removal agitators used in lifting forest tree seedlings with the Georgia seedling harvester.

The harvester basically consists of a heavy metal frame., large wheels and tires which provide flotation under wet soil conditions, a mechanical agitator for removing soil, a power unit, a rack for holding containers, a cross conveying system for placing plants in containers, and a lifting unit (fig. 3). The lifting unit is suspended and has a. floating action. Height of the lifting belts above seedbeds can be adjusted by the tractor drawbar or a hydraulic cylinder. When in operation the lifting belts are approximately 1 inch above the soil surface. Belts used on the harvester were specially designed by the Dayton Rubber Company. They are 250 inches long, 2 inches wide, and are notched on both sides for operating on very small pulleys. The outer surface of the belt is soft rubber for plant protection.

Pressure may be applied, to the lifting belts to prevent plants from being pulled from between them during harvesting (fig. 4). The belts slide on a thin metal strip extending the full length of the lifting unit. 'This thin metal strip is backed with sponge

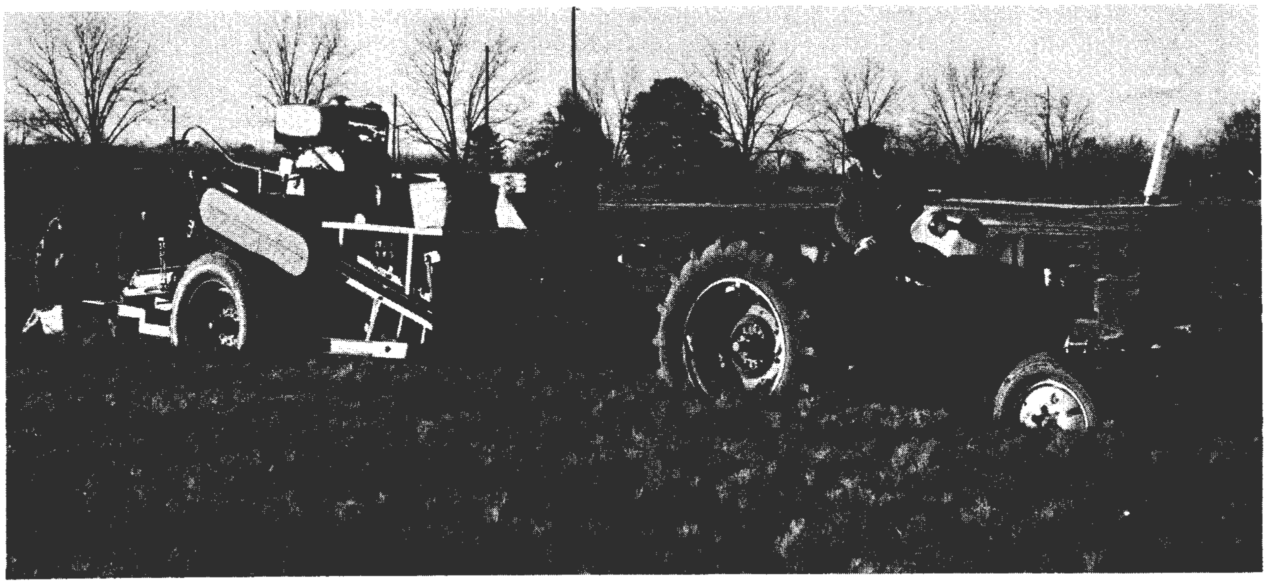

Figure 3.--Georgia seedling harvester in action.

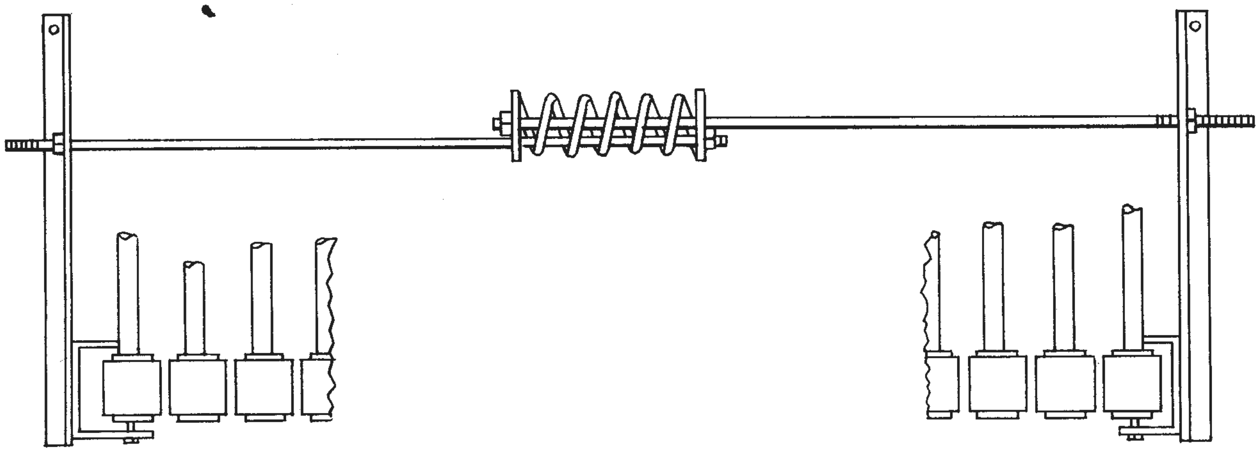

Figure 4.--Schematic diagram of unit for applying pressure to belts to prevent plants from being pulled from belts during harvesting.

rubber and is fastened to the frame unit. The rubber backing is another precaution to prevent plant injury as pressure is applied (fig. 5). The front shafts of the lifting unit turn to avoid bearing failure. They are mounted in take-up bearings to permit belt tension adjustments. As seedlings leave the machine an adjustable bar trips the plants and causes them to fall straight across the cross conveyor (fig. 6). The conveying unit then moves harvested seedlings into a container.

The seedling harvester is equipped with a 25-hp. air-cooled engine. In the experimental model, power was obtained from use of the power takeoff unit of the tractor. This proved unsatisfactory and a power unit was added to the modified harvester. The speed of the soil removal units and the cross conveyor system is related to engine speed but can be changed by exchanging sprockets. The rearward speed of the lifting belts can be varied by changing the engine r.p.m.

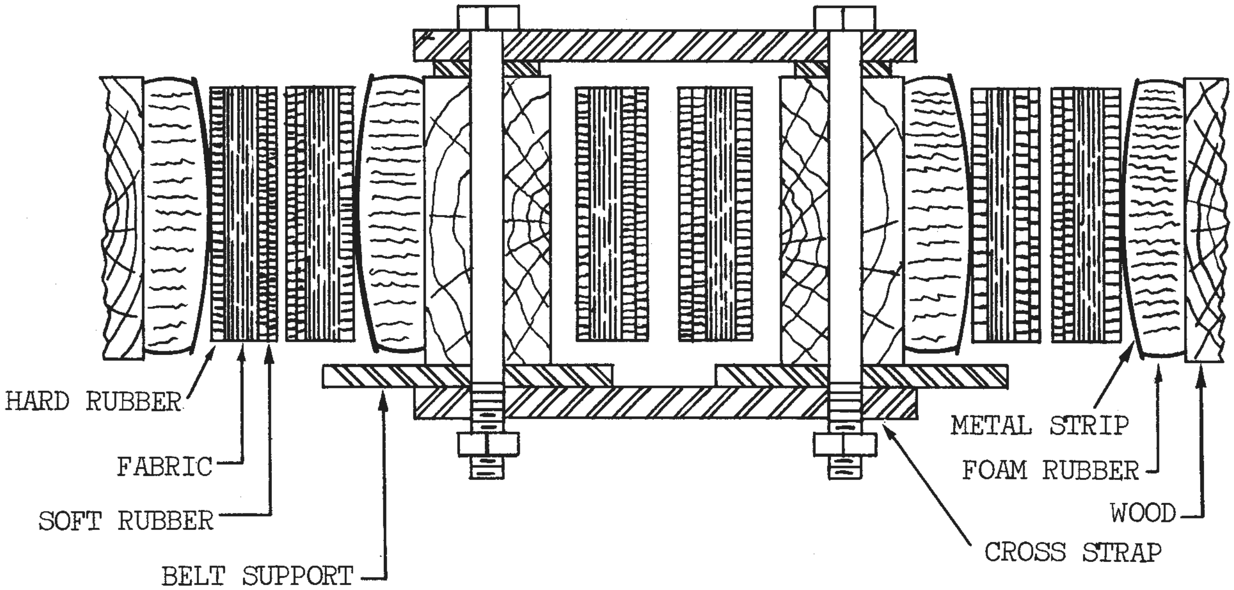


Figure 5.--Typical cross section of one lifting belt unit from the Georgia seedling harvester, showing construction details.

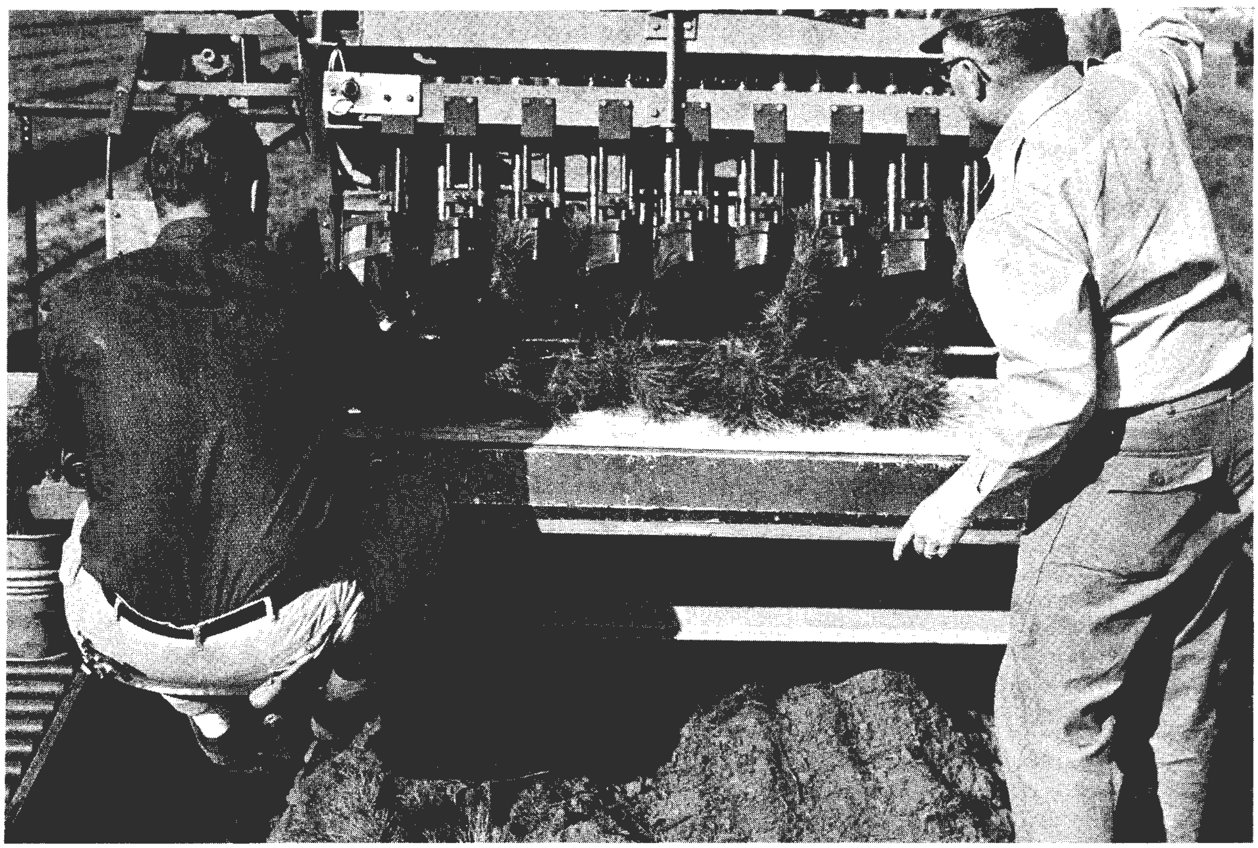

Figure 6.--Rear view of Georgia seedling harvester showing plants being discharged from lifting belts, trip bar, and cross conveyor system.

Successful operation of the Georgia seedling harvester depends on proper adjustment of the machine and trained operators. A crew of six is required. One person is needed to remove tubs from the storage rack and place them on the tub conveyor. Two men tend the rear of the machine where seedlings are discharged onto the cross conveyor. In event lifting belts become overloaded these men remove excess plants. The individual removing trees from the cross conveyor and placing same in containers is the most important worker on the harvester. He is the key to successful operation as the crew is built around him. The fifth worker removes filled containers from the harvester and inspects each to insure that all plant roots are covered to prevent exposure. A tractor driver is the sixth member of the crew.

Records from Georgia nurseries reveal that approximately 200 man-hours are required to remove a million seedlings from the soil and place them in containers when harvesting manually. Field tests show the Georgia machine is capable of harvesting one million seedlings in 48 man-hours, thus a saving of 152 man-hours per million trees harvested. The need for seasonal workers will be sharply reduced when the mechanical harvester is used. Employees lifting seedlings will not be affected by adverse weather conditions nearly as much as hand-lifting crews. Another advantage of mechanical harvesting is that soil compaction is much less than that due to tramping by labor used in hand lifting. A major and much needed advantage is that nurserymen will have flexibility in shipping. Large quantities of trees can be harvested as needed, thereby permitting continuous packaging operations during optimum planting periods.

On October 29, 1960, the modified machine successfully harvested several 500-foot beds of loblolly pine seedlings at the Commission's Morgan Nursery, Byron, Ga. To date it has been 95 percent effective in harvesting slash and loblolly seedlings. It has met the requirements designated at the initiation of the project and has proved that it can harvest pine trees. It will be put into full-time use during the fall of 1962 to determine if it will stand the trial of continuous use. The cooperating agencies feel that they have reached a point in development where production by some reliable manufacturer will be desirable when field testing is completed.